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The Region of the Elbow

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for the head and tuberosities coalesce and form the upper epiphysis, which is not united to the shaft until about the twenty-second year. The radial portion of the articular surface of the lower end of the humerus is developed by a centre of ossification in the third year, and the ulnar surface does not begin to ossify before the twelfth year. The internal epicondyle is formed about the fifth year, and the external epicondyle in the fourteenth year. The epicondyles and the trochlear surface become united about the seventeenth year and form the lower epiphysis, which generally unites with the shaft a year later. It should be noted that after the sixteenth year the growth of the humerus chiefly depends upon the upper epiphysis.

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The elbow is formed by the lower end of the humerus and the upper end of the ulna, which are so adapted to each other that they establish a hinge-joint of very considerable strength, by which the arm is connected with the forearm. The peculiar conformation of the lower end of the humerus has already been described (page 348). The upper end of the ulna is one of the most remarkable portions of the skeleton, and possesses many singular features. It consists of two conspicuous processes separated by a deep hollow. The process which extends backward is called the olecranon, because it forms the prominence of the elbow. It is a thick, strong, bony eminence ending in a curved tip which is received into the olecranon fossa of the humerus when the forearm is extended. The base of the olecranon process is constricted where it joins the shaft, corresponding to the line of the olecranon epiphysis, and is the usual seat of fracture when this part of the bone is broken. The upper posterior surface of the olecranon is somewhat square-shaped, and presents a rough impression for the attachment of the triceps muscle (page 354). The anterior surface is smooth, and forms the upper part of the deep hollow called the greater sigmoid cavity, which articulates with the trochlear surface on the humerus. The bottom of this cavity is marked transversely by a line, which indicates the constriction at the base of the olecranon above referred to. The cavity terminates below in the coronoid process, the broad projection from the shaft of the ulna which
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curves upward and ends in a point which rests in the coronoid fossa of the humerus when the forearm is flexed. The base of the coronoid process is thick and directly continuous with the shaft of the ulna. There is no epiphysis for this process, and its fracture is hardly possible. The brachialis anticus muscle is attached to the base of the process and contiguous part of the shaft. Upon the outer surface of the coronoid process there is a narrow oblong hollow, called the lesser sigmoid cavity, in which the adjacent head of the radius rolls. The upper end of the radius, although it is present within the elbow-joint, does not properly take part in the function of that joint. The contiguous portions of the elbow are peculiarly adapted to the retention of the upper end of the radius in position, so that the function which it possesses in relation to the hand through the wrist-joint may be maintained and act harmoniously with the movements at the elbow. The upper end of the radius is called its head. It consists of a round disk with a cupped depression which glides upon the capitulum on the outer condyloid surface of the humerus. The inner part of the marginal surface of the head is held in contact with the lesser sigmoid cavity of the ulna, in the ordinary position of the forearm, by means of the orbicular ligament. In the rotation of the radius the greater part of the margin of the head may revolve within the cavity. Below the head the bone is cylindrical and constricted, forming the neck, which joins the shaft at the prominent tubercle on the inner side of the bone, at the posterior and under surface of which the tendon of the biceps muscle is attached.

The elbow-joint is a ginglymus or hinge joint. The sigmoid cavities of the ulna and the trochlear surface of the humerus are covered with a layer of articular cartilage, as are also the depression and margin of the head of the radius. As stated above, the latter is present at the elbow in order merely that its function of rotation may be properly adjusted to the contemporaneous movements of the ulna. It is therefore not attached to the humerus by any special ligament, but with the ulna it is firmly held in close relation by the orbicular ligament, which forms a sort of collar round the neck of the radius, its ends being attached to the anterior and posterior borders of the lesser sigmoid cavity. This constitutes the
superior radio-ulnar joint, the chief function of which is to prevent the biceps muscle from dislocating the radius forward. The lower margin of the orbicular ligament is quite straight, and much narrower than the upper part, which is looser and blends with the fibres of the anterior and external portions of the capsular ligament surrounding the elbow. The capsular ligament is of unequal density, and is attached to the humerus over the coronoid fossa in front, to the margins of the olecranon fossa behind, and on each side to the lower surface of the epicondyles. Below, the capsule is attached to the ulna on the external borders of the olecranon and coronoid processes, and to the inner edge of the greater sigmoid cavity, and externally it is connected with the upper part of the orbicular ligament.

The capsular ligament is strengthened by accessory fibres, which are sometimes specialized as anterior, posterior, internal lateral, and external lateral ligaments. They are inseparable from the rest of the capsule, but it is important to note their peculiarities, as they in a measure limit the extent of motion at the joint. The anterior ligament consists of an oblique band of fibres extending from the internal epicondyle to the outer part of the coronoid process and the adjacent orbicular ligament. They assist in preventing over-extension. A few of the fibres of insertion of the brachialis anticus muscle are attached to this part of the capsule, so that in flexion the latter is drawn upward from between the bones. The internal lateral ligament consists of strong fibres which pass from the internal epicondyle in a radiating manner, some being attached to the coronoid process and some to the olecranon process, while a small band of fibres extends transversely between the two processes across the internal notch of the greater sigmoid cavity, thus affording protection to the small vessels which here enter the joint. From the internal lateral ligament the flexor sublimis digitorum muscle arises (page 381). The fibres composing the external lateral ligament pass from the external epicondyle to the orbicular ligament, and receive the origin of the extensor communis digitorum and supinator brevis muscles. The posterior ligament is very weak, and is composed of thin, loose fibres which extend over the back of the joint from the margin of the olecranon fossa to the borders of the olecranon process. As some of the deep fibres of the triceps are inserted
into it, it is drawn upward with the contraction of that muscle. When
the capsule is opened, several quite large fatty masses are usually found
contained within the folds of the synovial membrane, and occupying the
several fossæ on the end of the humerus and the notches at the sides of
the greater sigmoid cavity of the ulna. The *synovial membrane* lines
the entire capsule, and is widest and loosest beneath the tendon of the
triceps muscle, as is demonstrated by the enlargement on each side of
the olecranon in cases of synovitis. It is well to note here also that in
all cases of chronic distention of the elbow-joint from disease the posi-
tion of semi-flexion is assumed, which naturally enables the joint to hold
the greatest amount of fluid. The inner surface of the orbicular liga-
ment is also provided with a reflection of the synovial membrane, which
facilitates the rotation of the head of the radius. There are several smaller
folds of the membrane in relation to the orbicular ligament. One projects
between the head of the radius and the capitulum, and another between
the lower border of the lesser sigmoid cavity and the neck of the radius.
The latter restrains somewhat the movements of pronation and supination.
The movements of flexion and extension at the elbow are probably not
hindered by the olecranon and coronoid processes of the ulna, because their
respective fossæ on the humerus receive them completely; but the liga-
ments and tendons in front of and behind the joint exert a considerable
degree of restraint. A knowledge of this fact is of great importance in
the treatment of all injuries about the elbow, as the thickening resulting
from plastic inflammation occurring in such cases about these ligaments
and tendons is very apt to produce ankylosis. It is one of the reasons
why early and repeated passive motion should be resorted to upon the
subsidence of acute inflammatory symptoms in every case of sprain or
fracture at the elbow.

In consequence of the *obliquity* of the trochlear surface of the lower
end of the humerus, when the elbow is extended and the hand supinated
the forearm diverges from the line of the arm at an angle of about ten
degrees. A line drawn through the epicondyles on the lower end of the
humerus will form a right angle with the axis of the arm, but an obtuse
angle with the axis of the forearm. This explains why in flexion the
PLATE 49.

Figure 1.
Dissection of the muscles of the right forearm and hand in pronation to show the relations of the extensor tendons of the thumb to the radial artery.

1. The tendon of the biceps muscle.
2. The supinator longus muscle.
3. The extensor radii longior muscle.
4. The extensor communis digitorum muscle.
5. The tendon of the extensor radii brevis muscle.
6. The posterior annular ligament.
7. The tendon of the extensor secundii internodi pollicis muscle.
8. The tendon of the extensor radialis longior muscle.
9. The tendon of the extensor indicis muscle.
10. The tendon to the index finger from the extensor communis digitorum muscle.
11. The tendon of the middle finger.
12. The flexor carpi radialis muscle.
13. The flexor sublimis digitorum muscle.
14. The tendon of the flexor carpi radialis muscle, at the wrist.
15. The extensor ossis metacarpi pollicis muscle.
16. The extensor primi internodi pollicis muscle.
17. The radial artery.
18. The abductor pollicis brevis muscle.
19. One of the tendons of the adductor interosseus muscle to the middle finger, blending with the tendon of the common extensor muscle.

Figure 2.
Dissection of the muscles and tendons of the back of the right forearm and hand, in extension.

1. The internal condyle of the humerus.
2. The extensor carpi ulnaris muscle.
3. The extensor communis digitorum muscle.
4. The extensor minimi digiti muscle.
5. The posterior annular ligament.
6. The tendon of the extensor radialis brevis muscle.
7. The tendon to the little finger from the common extensor muscle.
8. The tendinous slip connecting the tendons to the middle and ring fingers.
9. The extensor communis digitorum muscle.
10. The supinator longus muscle.
11. The extensor carpi radialis longior muscle.
12. The extensor carpi radialis brevis muscle.
13. The tendon of the extensor radialis brevis muscle.
14. The extensor carpi ulnaris muscle.
15. The third dorsal interosseus muscle.
16. The branches of the ulnar nerve to the ring and little fingers.
17. The common nerve to the adjacent sides of the ring and middle fingers.
18. One of the dorsal interossei arteries.

Figure 3.
Dissection of the tendons on the back of the left hand, showing the relations of the nerves and arteries.

1. The extensor ossis metacarpi pollicis muscle.
2. The extensor primi internodi pollicis muscle.
3. The extensor secundii internodi pollicis muscle.
4. The tendon of the extensor carpi radialis brevis muscle.
5. The tendon of the extensor carpi radialis longior muscle.
6. Branches of the radial nerve to the thumb and index finger.
7. The posterior annular ligament.
8. The common nerve to the adjacent sides of the thumb and index finger.
9. The abductor pollicis muscle.
10. The nerves to the adjacent sides of the index and middle fingers.
11. The tendon of the index finger in its aponeurotic sheath.
12. The extensor carpi ulnaris muscle.
13. The shaft of the ulnar.
14. The third dorsal interosseus muscle.
15. The branches of the ulnar nerve to the ring and little fingers.
16. Common nerve to the adjacent sides of the ring and middle fingers.
17. The tendon to the middle finger from the common extensor muscle.
18. One of the dorsal interossei arteries.
forearm inclines inward, so that the hand is brought toward the middle line of the body, and also why it is not possible for the hand to be placed flat upon the shoulder of the same side. When the forearm is extended, the epicondyles of the humerus and the olecranon process of the ulna will be found to lie in a direct transverse line, but when it is flexed these points form a triangle, the olecranon being brought forward in front of the transverse line through the epicondyles. The olecranon process is nearer to the internal than to the outer epicondyle. When the olecranon is very prominent, its summit will be found in extreme extension above the transverse line. These bony prominences constitute the chief landmarks of this region, and, as they can always be felt through the skin, their relation in flexion and extension, as above indicated, should be carefully noted in all injuries to the elbow. It may also be observed that here, as in all other joints, much uncertainty may be removed by reference to the similar features upon the opposite limb.

The skin over the front of the elbow is very thin and fine, and, although there may be more or less fat in the subcutaneous tissue, the relations of the tendon of the biceps muscle can generally be easily recognized; whereas behind, over the olecranon, the skin is loosely attached with a thickened and roughened cuticle, which in extension is puckered into transverse wrinkles. In front of each elbow there is upon the outer side a prominence corresponding to the bulging of the mass formed by the supinator longus and extensor muscles, and upon the inner side there is a prominence caused by the pronator radii teres and flexor muscles. Between these the tendon of the biceps muscle descends into the ante-cubital fossa, thus formed, and in well-developed arms a groove is noticeable extending upward on each side of the tendon to blend respectively with the outer and inner bicipital depressions. The outer border of the tendon of the biceps can be distinguished better than the inner, owing to the reflection from the latter of the semilunar bicipital fascia.

The superficial veins at the bend of the elbow, usually described as presenting an M-shaped figure, are not always so arranged, because the veins are liable to great diversity in their disposition (Plates 45, 46, and 47) over the bicipital fascia. The deviation is most common
upon the radial side, in consequence of the radial tributary veins being deficient. Ordinarily the radial veins from the radial side of the forearm pass upward to empty into the cephalic vein (page 349), and the ulnar veins empty into the basilic vein (page 351), while the anterior median vein ascends from the wrist to the bend of the elbow, where, after receiving the blood from the deep veins of the forearm by means of the vena anastomotica (Plate 46, Fig. 2, No. 10, and Plate 47, Fig. 2, No. 16), it divides into two branches, respectively known as the median basilic and median cephalic veins. The median basilic vein generally occupies the inner bicipital groove and joins the posterior ulnar vein above the internal epicondyle as it empties into the basilic vein, while the median cephalic vein follows the outer bicipital groove and joins the radial veins to form the cephalic vein. These veins can usually be distinguished through the integument if there is not a great deal of fat. The median basilic vein, owing to its larger size, its prominence, and its comparatively fixed relations, has been usually selected for venesection in this region. Its course is over the bicipital fascia, and corresponds so closely to that of the brachial artery beneath the fascia that it may in some thin individuals receive the pulsations from the artery.

The strength and denseness of the bicipital fascia depend upon the general muscular development, as is the case with the expansions of the deep fascia elsewhere. Occasionally at the elbow two median basilic veins are found (Plate 46). Branches of the internal cutaneous nerve usually pass close to the inner side of the median basilic vein, while filaments of the musculo-cutaneous nerve pass to the skin of the forearm at its outer side. Beneath the superficial fascia the relations of the vessels and nerves on either side of the tendon of the biceps muscle are of great interest. In the outer groove between the tendon and the supinator longus muscle are the terminations of the musculo-cutaneous and musculo-spiral nerves, and the superior profunda and radial recurrent arteries (Plate 46, Fig. 1, No. 10). In the inner groove beneath the bicipital fascia are the median nerve, the brachial artery and its two companion veins, and the communication between the anastomotica and anterior recurrent ulnar arteries. The median nerve at the elbow is at the ulnar side of the brachial artery, and
descends beneath the fascia between the two heads of the pronator radii teres muscle (page 379), having previously distributed branches to the superficial flexor muscles and to each head of the pronator. The *brachial artery at the elbow* passes beneath the bicipital fascia to the middle of the joint, where opposite the head of the radius it bifurcates into the radial and ulnar arteries. As the brachialis anticus muscle passes over the elbow-joint to be inserted into the coronoid process of the ulna, it supports the termination of the brachial artery, besides serving as a covering to the joint. In forcible flexion of the elbow it is possible effectually to compress the artery between the masses of muscle, but such pressure, necessarily involving the median nerve also, is so painful that it cannot be endured more than a short time. When the bicipital fascia is removed, the origins of the *brachial veins* from the deep venæ comites of the vessels of the forearm and their relations to the brachial artery are exposed (Plate 46, Fig. 2, No. 8). Between the olecranon process and the internal epicondyle the ulnar nerve is lodged in a groove, which is subcutaneous (page 359). It is in close relation with the posterior recurrent ulnar artery. Sometimes the ulnar nerve passes in front of the epicondyle instead of behind it. Just below the external epicondyle there is a depression which is always to be seen even when there is much fat in the subcutaneous tissue. This depression adds much to the graceful contour of this part of the forearm, and it is most marked when the latter is extended. The depression corresponds to the interval between the supinator longus and extensor carpi radialis muscles and the external border of the anconeus muscle. It is important surgically, as the head of the radius can be felt in it when the bone is rotated, and because it thus affords a means of distinguishing the line of the elbow-joint. If the forearm is placed in the position of extreme pronation, the tubercle of the radius can be felt below the head. The *superficial lymphatic vessels of the forearm* accompany the superficial veins toward the inner side of the elbow, and terminate in a *lymphatic gland* situated just above the internal epicondyle. This gland is apt to be involved in any septic affection of the fingers or hand, and should be remembered, as it is the lowest gland in the upper extremity.
There are three bursæ about the elbow, one between the attachment of the tendon of the biceps and the tubercle of the radius, a small one occasionally over the internal epicondyle, and a large one over the olecranon process. The latter is frequently enlarged, and when inflamed may affect the joint, as there is a communication between it and the synovial membrane. The elbow-joint is supplied by filaments from both the ulnar and the median nerve. In some injuries to the joint severe pain is experienced in the parts of the forearm corresponding to the distribution of these nerves. The anastomoses of the arteries about the olecranon process and the posterior part of the capsule of the elbow establish the rete olecrani. The vessels forming it are derived from the anastomotica and superior and inferior profunda arteries, which are branches of the brachial artery, and from the posterior ulnar recurrent and interosseous recurrent arteries. It is important to note that their disposition is such that the circulation through them is not interrupted by the tension of the superficial fascia in extreme flexion of the elbow, when the current in the brachial artery at its bifurcation may be arrested by pressure. It should be observed also that the arteries about the internal epicondyle are more numerous than those about the external.

The commonest form of dislocation of the elbow is where the bones of the forearm are driven backward upon the lower end of the humerus. In such cases, when the displacement is complete, the coronoid process will be found opposite the olecranon fossa, with the head of the radius projecting behind the external epicondyle. The anterior and lateral ligaments of necessity are torn, the orbicular is rarely affected, and the posterior may or may not be torn, according to the nature and direction of the violence. The tendon of the biceps appears like a tense cord drawn over the trochlear surface of the humerus, while the attachment of the brachialis anticus is usually ruptured. The median and ulnar nerves are necessarily stretched.

Fractures of the lower end of the humerus which involve the elbow-joint occur most commonly in young persons. They are caused by direct violence received upon the point of the elbow. Sometimes the olecranon process is driven so forcibly into the olecranon fossa that the end of the
humerus is split across transversely at its base, or it may be complicated by a vertical separation of the condyloid portions of the bone, thereby constituting a T-shaped fracture. Of the two epicondyles, it may be said that the external, on account of its slight prominence and construction, is very rarely if ever broken by itself, whereas the internal often suffers fracture. The latter, prior to the age of eighteen years, may be detached at its epiphysis (page 362). There is seldom displacement following fracture of the internal epicondyile, as it is enveloped by the dense aponeuroses of the common flexor muscles of the forearm. In children, when there is a separation of the lower epiphysis of the humerus there is naturally very little deformity, in consequence of the epiphyseal line being almost wholly within the capsule of the elbow. Fracture of the olecranon process occurs most frequently just above the constriction through the greater sigmoid cavity, and corresponds to the epiphyseal line. The degree of displacement depends upon the extent to which the periosteum and ligaments are ruptured, and the consequent unrestricted contraction of the triceps muscle. Fracture of the coronoid process of the ulna, or of the head or neck of the radius, can hardly occur except in severe injuries attended with dislocation and extensive contusion, owing to their anatomical relations.

The relations of the parts as they are found in the flaps after amputation at the elbow-joint by the antero-posterior flap method (on the left side) are as follows (Plate 51, Fig. 2). The anterior flap is composed chiefly of the biceps and brachialis anticus muscles, and contains the severed median nerve (No. 1), and the brachial artery (No. 2) and its veins (No. 3). In relation to the internal epicondyle are the ulnar nerve and the posterior recurrent ulnar artery, while the musculo-spiral nerve is in close proximity to the external epicondyle, and the radial recurrent artery is in the outer angle of the flaps. The posterior flap is composed of the integument and the tendon of the triceps muscle (No. 12), the latter attached to the severed olecranon process of the ulna. At the inner border of the posterior flap there is a recurrent branch of the ulnar artery, and in the inner angle between the flaps is the anastomotica magna artery.

In resection of the elbow there is always danger of injuring the ulnar
nerve, owing to its close relation to the internal epicondyle and the difficulty of detaching the soft structures from that bony prominence. It is very important to preserve the periosteum over the olecranon and the strong fascia over the anconeus muscle, so that the triceps may not be altogether severed from the ulna. The relations of the parts exposed in the procedure by a posterior vertical incision (on the left side) are as follows (Plate 52, Fig. 6): the severed tendon of the triceps (No. 2) will be seen just above the trochlear surface of the lower end of the humerus (No. 3); upon the outer side of the olecranon process, which is denuded of its periosteum (No. 8), are the head of the radius (No. 4) and the radial recurrent artery (No. 5), while upon the inner side are the ulnar nerve (No. 7) and the posterior ulnar recurrent artery (No. 9).

As an illustration of the possible degree of injury which the elbow may recover from without loss of power or motion, the author may be justified in noticing in this connection a case recently under his care. The patient, a young man aged twenty-one years, received fractures of the internal epicondyle and the upper end of the ulna below the coronoid process in consequence of a fall upon the elbow while it was in a semi-flexed position. Seven weeks later, when he was regaining the use of the elbow, after constant passive motion, he met with another fall and fractured the olecranon of the same elbow through the greater sigmoid cavity. Owing probably to the passive use to which the triceps had been so recently subjected, and certainly to the extensive laceration of the ligaments and the periosteal connections, the process was drawn a hand’s breadth away from its proper site. The local contusion and extravasation in both instances were unusually great, but, by careful perseverance, within two months complete use of the joint was obtained, both as to power and as to motion, and measurement proved that the olecranon was consolidated again with the ulnar shaft without any separation,—an unusual feature.

THE REGION OF THE FOREARM.

The shafts of the radius and the ulna, beyond their upper extremities, already described with the elbow, extend side by side to the wrist, and are peculiarly formed, not only to support the soft structures of the forearm.